FORM PTO-1390 (REV. 9-2001) U S DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE

TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371

ATTORNEY 'S DOCKET NUMBER: 1435

U S APPLICATION NO (If known, see 37 CFR 1 5): 10/030233

INTERNATIONAL APPLICATION NO.	INTERNATIONAL FILING DATE	PRIORITY DATE CLAIMED
PCT/SE00/01320	21 June 2000 (21.06.00)	6 July 1999 (06.07.99)

TITLE OF INVENTION: A METHOD AND ARRANGEMENT FOR CONTROLLING A TUNEABLE LASER

APPLICANT(S) FOR DO/EO/US: Björn BROBERG and Markus RENLUND

Applicant herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:

1. [X] This is a **FIRST** submission of items concerning a filing under 35 U.S.C. 371.
2. [ ] This is a **SECOND** or **SUBSEQUENT** submission of items concerning a filing under 35 U.S.C. 371.
3. [ ] This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.
4. [X] The US has been elected by the expiration of 19 months from the priority date (Article 31).
5. [X] A copy of the International Application as filed (35 U.S.C. 371(c)(2))
   a. [X] is attached hereto (required only if not communicated by the International Bureau).
   b. [ ] has been communicated by the International Bureau.
   c. [ ] is not required, as the application was filed in the United States Receiving Office (RO/US).
6. [X] An English language translation of the International Application as filed (35 U.S.C. 371(c)(2)).
   a. [X] is attached hereto.
   b. [ ] has been previously submitted under 35 U.S.C. 154(d)(4).
7. [X] Amendments to the claims of the International Aplication under PCT Article 19 (35 U.S.C. 371(c)(3))
   a. [ ] are attached hereto (required only if not communicated by the International Bureau).
   b [ ] have been communicated by the International Bureau.
   c. [ ] have not been made; however, the time limit for making such amendments has NOT expired.
   d. [X] have not been made and will not be made.
8. [ ] An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).
9. [ ] An oath or declaration of the inventor(s) (35 U.S.C. 371(c)(4)).
10. [X] An English lanugage translation of the annexes of the International Preliminary Examination Report under PCT Article 36 (35 U.S.C. 371(c)(5)).

Items 11 to 20 below concern document(s) or information included:

11. [X] An Information Disclosure Statement under 37 CFR 1.97 and 1.98.
12. [ ] An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.
13. [X] A FIRST preliminary amendment.
14. [ ] A SECOND or SUBSEQUENT preliminary amendment.
15. [X] A substitute specification.
16. [ ] A change of power of attorney and/or address letter.
17. [ ] A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821 - 1.825
18. [ ] A second copy of the published international application under 35 U.S.C. 154(d)(4).
19. [ ] A second copy of the English language translation of the international application under 35 U.S.C 154(d)(4).
20. [X] Other items or information:
    International Search Report
    International Preliminary SearchReport
    Initial Information Data Sheet
    Receipt Postcard

Express Mail Label No. ET964319600US

U.S. APPLICATION NO (if known, see 37 CFR 1 5)	INTERNATIONAL APPLICATION NO	ATTORNEY'S DOCKET NUMBER
10/030233	PCT/SE00/01320	1435

21. [X] The following fees are submitted:

BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):

	CALCULATIONS PTO USE ONLY
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO **$1040.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO **$890.00**	
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but international search fee (37 CFR 1.445(a)(2)) paid to USPTO **$740.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) **$710.00**	
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33(1)-(4) **$100.00**	
ENTER APPROPRIATE BASIC FEE AMOUNT =	$ 1040
Surcharge of **$130.00** for furnishing the oath or declaration later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(e)).	$

CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE	
Total claims	5 - 20 =	0	x **$18.00**	$ 0
Independent claims	1 - 3 =	0	x **$84.00**	$ 0
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+ **$280.00**	$
TOTAL OF ABOVE CALCULATIONS =				$ 1040
[ ] Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by 1/2.			+	$
SUBTOTAL =				$ 1040
Processing fee of **$130.00** for furnishing the English translation later than [ ] 20 [ ] 30 months from the earliest claimed priority date (37 CFR 1.492(f)).				$
TOTAL NATIONAL FEE =				$ 1040
Fee for recording the enclosed assignment (37 CFR 1.21(h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). **$40.00** per property +				$
TOTAL FEES ENCLOSED =				$ 1040
			Amount to be refunded:	$
			charged:	$

a. [ ] A check in the amount of $ _____ to cover the above fees is enclosed.

b. [X] Please charge my Deposit Account No. 501300 in the amount of $ 1040.00 to cover the above fees. A duplicate copy of this sheet is enclosed.

c. [X] The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. 501300 . A duplicate copy of this sheet is enclosed.

d. [ ] Fees are to be charged to a credit card. **WARNING:** Information on this form may become public. **Credit card information should not be included on this form.** Provide credit card information and authorization on PTO-2038.

NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.

SEND ALL CORRESPONDENCE TO.

Alfred J. Mangels
4729 Cornell Road
Cincinnati, Ohio 45241-2433

SIGNATURE

Alfred J. Mangels
NAME

22,605
REGISTRATION NUMBER

PATENT COOPERATION TREATY
IN THE UNITED STATES ELECTED OFFICE (EO/US)

In re application of:

Björn BROBERG et al.

Int'l. Appl'n. No.: PCT/SE00/01320

Int'l. Filing Date: 21 June 2000

Priority Date: 6 July 1999

For: A METHOD AND ARRANGEMENT FOR CONTROLLING A TUNEABLE LASER

PCT DO/EO Section

PRELIMINARY AMENDMENT

Commissioner for Patents
Washington, D.C. 20231

Dear Sir:

Prior to examination, and before the calculation of the national filing fee, please amend the above-identified international application as follows:

IN THE SPECIFICATION:

Kindly enter the substitute specification attached hereto as Attachment A. The substitute specification includes no new matter. Also enclosed, as Attachment B, is a copy of the substitute specification showing all the changes, including the matter being added to and the matter being deleted from the specification that forms part of the published international application upon which the present application is based (PCT/SE00/01320, publication No. WO 01/03262).

IN THE CLAIMS:

The rewritten claims in this application are as follows:

1. (Amended) A method of controlling a tuneable laser that has been characterized with respect to one or more suitable laser operation points, where each of said operation points is determined by the manner in which different laser sections are controlled in order to operate the laser at a predetermined operation point, said method comprising the steps of: determining voltages across different laser sections for different operation points when controlling said laser; and holding the determined voltages across the different laser sections constant when the laser is in operation, to maintain a predetermined laser operation point.

2. (Amended) A method according to Claim 1, including the step of applying predetermined constant voltages across respective laser sections from a voltage source.

3. (Amended) A method according to Claim 2, including the steps of measuring the voltages across respective laser sections, and adjusting the voltage source to maintain said predetermined voltages across each laser section.

4. (Amended) An arrangement for controlling a tuneable laser that has been characterized with respect to suitable laser operation points, where said operation points are determined by currents to be injected into the different laser sections in order for the laser to operate at a predetermined operation point, said controlling arrangement comprising: a voltage source which during operation of the laser functions to hold

voltages across different laser sections constant over time in accordance with a voltage that was measured across the different laser sections in respect of different operation points measured when characterizing the laser, to maintain a predetermined laser operation point.

5. (Amended) An arrangement according to Claim 4 comprising a circuit to measure voltages across respective laser sections, wherein the circuit is adapted to adjust the voltage source to maintain said predetermined voltages across each laser section.

REMARKS

The specification changes reflected in the enclosed substitute specification (Attachment A) include the addition of the preferred subheadings at appropriate places within the specification, and they also include minor corrections. None of the changes made in the substitute specification introduces new matter because each change is based upon the international application in the form in which it was published. Attachment B shows the changes that were made in the substitute specification to the specification that was published by the International Bureau.

The claims as above amended present the claimed subject matter in the U.S. claim form to more particularly point out and more distinctly claim the subject matter that the applicants regard as their invention.

Attached hereto as Attachment C is a set of the claims as they were allowed in the international application, showing all additions, deletions, and modifications of those claims that are reflected in the clean claims presented above.

Also attached hereto is an Abstract of the Disclosure presented on a separate sheet in conformity with the rules of practice.

Based upon the specification and claim amendments to this national phase application, it is believed that the specification conforms with U.S. formal requirements. Additionally, the amended claims as hereinabove presented conform in substance with the corresponding claims that were examined in the international application. And based upon the acceptance by the International Preliminary Examining Authority of the invention as it was claimed in the claims as they were presented in the international application as meeting each of the novelty, the inventive step, and the industrial applicability criteria set forth in the Patent Cooperation Treaty, the claims in the present application are believed to conform with both U.S. formal and substantive requirements, and they are therefore believed to be in allowable form. Accordingly, an early Notice of Allowance is in order and is respectfully solicited.

Should the examiner have any question after considering this Preliminary Amendment, he is cordially invited to telephone the undersigned attorney so that any such question can be quickly resolved, and in order that the present application can proceed toward allowance.

Respectfully submitted,

January 5, 2002

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2/prts

A METHOD AND ARRANGEMENT FOR CONTROLLING A TUNEABLE LASER

The present invention relates to a method and to an arrangement for controlling a tuneable laser.

Tuneable semiconductor lasers include several different sections through which current is injected, these sections typically being three or four in number. The wavelength, power and mode purity of the lasers can be controlled by adjusting the current in the various sections. Mode purity implies that the laser is at an operation point, i.e. at a distance from a combination of the drive currents where so-called mode jumps occur and where lasering is stable and side mode suppression is high.

Special requirements are required for different applications with respect to controlling wavelength. In the case of telecommunications applications, it is necessary that the laser is able to retain its wavelength to a very high degree of accuracy over long periods of time, after having set the drive currents and the temperature. A typical accuracy is 0.1 nanometer and a typical time period is 20 years.

In order to be able to control the laser, it is necessary to map the behaviour of the laser as a function of the various drive currents. This is necessary prior to using the laser after its manufacture.

Various methods of characterising tuneable lasers with respect to optimising their operation points are described in Swedish Patent Specifications 9800143-1 and 9900536-5.

However, it is also necessary to determine degradation of a laser in operation in order to be able to compensate for degradation by changing the drive currents. A change in wavelength for a given operation point is one example of degradation.

Conventionally, tuneable lasers are controlled by adjusting the current injected into the various laser sections so as to retain a certain desired operation point.

One method of discovering laser degradation is to re-characterise the laser after a given time period and therewith compare earlier combinations with the current combinations last measured so as to determine the extent to which the laser may have degraded. The current control of the various sections of the laser is then adjusted so as to obtain the desired operation point.

The present invention relates to a method and to an arrangement with which changes in the laser operation point with respect to transmitted wavelength, power and side mode suppression due to degradation is compensated so as to greatly reduce the influence of this degradation or to eliminate its influence entirely.

Accordingly, the present invention relates to a method of controlling a tuneable laser which has been characterised with respect to one or more suitable laser operation points, wherein each of the operation points is determined by the extent to which the various sections of the laser are controlled to result in the laser operating in a predetermined operation point, and is characterised by

determining the laser control voltage across the different sections for different operation points; and holding the voltage across the various sections of the laser constant during operation of the laser over time and thereby maintain a predetermined operation point.

The invention also relates to an arrangement that has the characteristic features set forth in Claim 4.

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, in which

- Figure 1 is a partially cut-away perspective view of a DBR laser;
- Figure 2 is a sectional view of a tuneable Grating Coupled Sampled Reflector (GCSR) laser;
- Figure 3 is a sectional view of a Sampled Grating DBR laser;
- Figure 4 shows principle curves in a diagram in which current injected in one tuning section is plotted against the voltage across said section; and
- Figure 5 is a block diagram illustrating schematically an arrangement used in accordance with the invention.

Figure 1 illustrates a DBR laser which includes three sections, namely a Bragg reflector 1, a phase section 2 and a gain section 3. Each section is controlled by injecting current thereinto through respective electrical conductors 4, 5, 6.

Figure 2 is a section view of a tuneable Grating Coupled Sampling Reflector (GCSR) laser. Such a laser has four

sections, namely a Bragg reflector 7, a phase section 8, a coupler 9 and a gain section 10. Each of the sections is controlled by injecting current thereinto.

Figure 3 is a section view of a Sampled Grating DBR laser, which also has four sections referenced 11, 12, 13, 14 respectively. The sections 11 and 14 are Bragg reflectors, whereas section 13 is the phase section and section 12 the gain section.

The aforesaid three types of lasers are common. However, other types of lasers exist.

Although the invention is described below mainly with reference to a GCSR laser according to Figure 2, it will be understood that the invention is not restricted to any particular kind of tuneable semiconductor lasers. For instance, the invention can be applied in a corresponding manner with tuneable lasers other than those shown in the Figures by way of example.

The wavelength emitted by a tuneable laser is determined by the amount of current that is injected into the different laser sections. Wavelength is determined by the number of free charge carriers to which the injected current gives rise. Degradation in the relationship between wavelength and current can occur in time and therewith destroy the wavelength accuracy of the laser.

This degradation occurs primarily in the relationship between current and refractive index, by virtue of a change in the

ratio between the injected current and the number of charge carriers.

The ratio between the number or charge carriers and refractive index, and therewith wavelength, however, can be considered to be constant.

Thus, the invention relates to a method of controlling a tuneable laser which has earlier been characterised with respect to one or more suitable laser operation points. The operation points are determined by the current to be injected into the different laser sections, or by the voltage that shall prevail across respective sections, in order for the laser to operate in a predetermined operation point.

According to the invention, the voltage across the different laser sections for different laser operation points is determined when characterising the laser. In operation, the voltage across the different laser sections is held constant over time so as to maintain a predetermined operation point.

The laser can be characterised in accordance with the aforesaid patent specifications, such as to identify a large number of operation points, and thereafter select a given operation point. However, the invention can also be applied when the laser is controlled digitally or analogously to obtain a given operation point. The invention is therefore not dependent on how a given operation point is obtained.

In fact, the relationship between current that passes through a section and the applied voltage across said section is not

linear and, furthermore, is changed with degradation of the laser. This applies to all laser sections.

Figure 4 is a diagram in which the current I through one section has been plotted against the voltage across said section. The curve 11 shows this relationship when characterising the laser prior to its degradation. The point 01 shows a selected operation point. The position of the curve 11 moves to the position of the curve 12 when degradation occurs. Thus, the operation point can be caused to move to the point 02, by holding the voltage constant. The result of holding the voltage constant is thus to increase the current through the section from I1 to I2.

This is preferably effected by causing the voltage unit 13 to supply voltage to each of the laser sections with predetermined constant voltages across respective sections.

This results in automatic correction of the current through respective sections and in a constant quantity of free charge carriers, even when the ratio between injected current and the number of charge carriers changes. This applies to all sections of the laser.

Consequently, the wavelength of the emitted light will be held constant over said time period even should the laser degrade. Although an exact wavelength may not be maintained over the full time period, the influence of degradation will at least be greatly reduced.

As distinct to conventional processes, it is not necessary to measure the current nor to correct the current to a certain predetermined value.

In actual fact, it is unnecessary to know the extent to which the laser has degraded in order to maintain a given operation point, and therewith wavelength, when practicing the present invention.

The present invention thus solves the problem disclosed in the introduction.

Figure 5 is a block diagram of an arrangement used in accordance with the invention.

In operation, the voltage unit 13 functions to keep the voltage across the different laser sections 7-10 constant over a time period for maintaining a predetermined operation point. The various voltages required in this respect are determined when characterising or controlling the laser as relevant voltages across the various laser sections for different operation points.

When characterising the laser, for instance in accordance with the aforesaid patent specifications, the voltage across the various laser sections can be measured in respect of the different operation points.

The arrangement includes a microprocessor 14 or some corresponding device for controlling four different voltage generators 16-19 via a D/A converter 15. Each of the voltage generators 16-19 controls one of the laser sections 7-10. The

microprocessor is connected to a storage in which the different operation points are stored in the form of that voltage which shall prevail across respective laser sections.

According to one preferred embodiment, the arrangement includes a circuit 20 which is adapted to measure the voltage across respective sections 7-10. The circuit 20 is designed to adjust the voltage unit 13 so that it will maintain a predetermined voltage for each laser section. This is effected in response to a signal delivered to the microprocessor 14 from the circuit 20 and representing respective measured voltages.

The microprocessor and the D/A converter can be replaced with a fully analog circuit. In such case, the circuit 20 may also be included in a similar analog circuit.

Although the invention has been described above with reference to an exemplifying embodiment thereof, it will be understood that the invention can be applied correspondingly to types of tuneable lasers other than a GCSR laser. The voltage generators may also be given any suitable design, as can also the circuit 20.

The present invention shall not therefore be considered limited to the aforedescribed embodiment, since variations can be made within the scope of the following Claims.

CLAIMS

1. A method of controlling a tuneable laser that has been characterised with respect to one or more suitable laser operation points, where each of said operation points is determined by the manner in which the different laser sections (7-10) are controlled in order to operate the laser in a predetermined operation point, **characterised** by determining the voltage across the different laser sections (7-10) for different operation points when controlling said laser; and holding the voltage across the different laser sections (7-10) constant when the laser is in operation, such as to maintain a predetermined operation point.

2. A method according to Claim 1, **characterised** by applying predetermined constant voltages across respective laser sections (7-10) with the aid of a voltage supply unit (13).

3. A method according to Claim 1 or 2, **characterised** by measuring the voltage across respective sections (7-10), and adjusting the voltage supply unit (13) so as to maintain said predetermined voltage across each section (7-10).

4. An arrangement for controlling a tuneable laser that has been characterised with respect to suitable laser operation points, where said operation points are determined by the current to be injected into the different laser sections (7-10) in order for the laser to operate in a predetermined operation point, **characterised** by a voltage unit (13) which during operation of the laser functions to hold the voltage across the different laser sections (7-10) constant over time in accordance with the voltage that was measured across the

different laser sections (7-10) in respect of said different operation points measured when characterising the laser, such as to maintain a predetermined operation point.

5. An arrangement according to Claim 4, **characterised** by a circuit (20) that functions to measure the voltage across respective sections (7-10), wherein the circuit (20) is adapted to adjust the voltage unit (13) to maintain said predetermined voltage across each section (7-10).

Abstract of the Disclosure

A method of controlling a tuneable laser that has been characterized with respect to one or more suitable laser operation points. Each operation point is determined by the manner in which the different laser sections are controlled, in order to operate the laser at a predetermined operation point. The voltage across the different laser sections is determined for different operation points when controlling the laser, and the voltages across the different laser sections are held constant when the laser is in operation to maintain a predetermined operation point.

ATTACHMENT A

SUBSTITUTE SPECIFICATION
(Including All Changes From the Specification in Published International Application No. PCT/SE00/01320)

A METHOD AND ARRANGEMENT FOR CONTROLLING A TUNEABLE LASER

Background of the Invention

Field of the Invention

The present invention relates to a method and to an arrangement for controlling a tuneable laser.

Description of the Related Art

Tuneable semiconductor lasers include several different sections through which current is injected, these sections typically being three or four in number. The wavelength, power, and mode purity of the lasers can be controlled by adjusting the current in the various sections. Mode purity implies that the laser is at an operation point, i.e., at a distance from a combination of the drive currents where so- called mode jumps occur and where lasing is stable and side mode suppression is high.

Special requirements are required for different applications with respect to controlling wavelength. In the case of telecommunications applications, it is necessary that the laser be able to retain its wavelength to a very high degree of accuracy over long periods of time, after having set the drive currents and the temperature. A typical accuracy is 0.1 nanometer and a typical time period is 20 years.

In order to be able to control the laser, it is necessary to map the behavior of the laser as a function of the various drive currents. This is necessary prior to using the laser after its manufacture.

Various methods of characterizing tuneable lasers with respect to optimizing their operation points are described in Swedish Patent Specifications 9800143-1 and 9900536-5.

However, it is also necessary to determine the degradation of a laser in operation in order to be able to compensate for degradation by changing the drive currents. A change in wavelength for a given operation point is one example of degradation.

Conventionally, tuneable lasers are controlled by adjusting the current injected into the various laser sections so as to maintain a certain desired operation point.

One method of discovering laser degradation is to recharacterize the laser after a given time period, and then compare earlier combinations with the current combinations last measured, to determine the extent to which the laser may have degraded. The current control of the various sections of the laser is then adjusted to obtain the desired operation point.

Summary of the Invention

The present invention relates to a method and to an arrangement with which changes in the laser operation point with respect to transmitted wavelength,

power, and side mode suppression due to degradation is compensated, to greatly reduce the influence of this degradation or to eliminate its influence entirely.

Accordingly, the present invention relates to a method of controlling a tuneable laser which has been characterized with respect to one or more suitable laser operation points, wherein each of the operation points is determined by the extent to which the various sections of the laser are controlled to result in the laser operating at a predetermined operation point. The laser control voltage across the different sections for different operation points is determined, and the voltage across the various sections of the laser is held constant during operation of the laser over time to thereby maintain a predetermined operation point.

The invention also relates to an arrangement that includes a voltage unit which during operation of the laser functions to hold the voltage across the different laser sections constant over time, in accordance with the voltage that was measured across the different laser sections in respect of the different operation points that were measured when characterizing the laser, to maintain a predetermined operation point.

Brief Description of the Drawings

The invention will now be described in more detail with reference to exemplifying embodiments thereof and also with reference to the accompanying drawings, in which

- Figure 1 is a partially cut-away perspective view of a DBR laser;

- Figure 2 is a sectional view of a tuneable Grating Coupled Sampled Reflector (GCSR) laser;

- Figure 3 is a sectional view of a Sampled Grating DBR laser;

- Figure 4 shows principal curves in a graph in which current injected in one tuning section is plotted against the voltage across said section; and

- Figure 5 is a block diagram illustrating schematically an arrangement that can be used in accordance with the invention.

Description of the Preferred Embodiments

Figure 1 illustrates a DBR laser which includes three sections, namely a Bragg reflector 1, a phase section 2, and a gain section 3. Each section is controlled by injecting current thereinto through respective electrical conductors 4, 5, 6.

Figure 2 is a sectional view of a tuneable Grating Coupled Sampling Reflector (GCSR) laser. Such a laser has four sections, namely a Bragg reflector 7, a phase section 8, a coupler 9, and a gain section 10. Each of the sections is controlled by injecting current thereinto.

Figure 3 is a sectional view of a Sampled Grating DBR laser, which also has four sections referenced 21, 22, 23, 24, respectively. The sections 21 and 24 are Bragg reflectors, whereas section 23 is the phase section, and section 22 is the gain section.

The aforesaid three types of lasers are common. However, other types of lasers exist.

Although the invention is described below mainly with reference to a GCSR laser according to Figure 2, it will be understood that the invention is not restricted to any particular kind of tuneable semiconductor lasers. For instance, the invention can be applied in a corresponding manner with tuneable lasers other than those shown in the Figures.

The wavelength emitted by a tuneable laser is determined by the amount of current that is injected into the different laser sections. Wavelength is determined by the number of free charge carriers to which the injected current gives rise. Degradation in the relationship between wavelength and current can occur in time and thereby destroy the wavelength accuracy of the laser.

This degradation occurs primarily in the relationship between current and refractive index, by virtue of a change in the ratio between the injected current and the number of charge carriers.

The ratio between the number of charge carriers and refractive index, and therewith wavelength, however, can be considered to be constant.

Thus, the invention relates to a method of controlling a tuneable laser which has earlier been characterized with respect to one or more suitable laser operation points. The operation points are determined by the current to be injected into the different laser sections, or by the voltage that exists across respective sections, in order for the laser to operate at a predetermined operation point.

According to the invention, the voltage across the different laser sections for different laser operation points is determined when characterizing the laser. In

operation, the voltage across the different laser sections is held constant over time to maintain a predetermined operation point.

The laser can be characterized in accordance with the aforesaid patent specifications, such as to identify a large number of operation points, and thereafter select a given operation point. However, the invention can also be applied when the laser is controlled digitally or analogously to obtain a given operation point. The invention is therefore not dependent on how a given operation point is obtained.

In fact, the relationship between the current that passes through a section and the applied voltage across said section is not linear, and, furthermore, is changed with degradation of the laser. This applies to all laser sections.

Figure 4 is a graph in which the current I through one section has been plotted against the voltage across said section. The curve 11 shows this relationship when characterizing the laser prior to its degradation. The point 01 shows a selected operation point. The position of the curve 11 moves to the position of the curve 12 when degradation occurs. Thus, the operation point can be caused to move to the point 02 by holding the voltage constant. The result of holding the voltage constant is thus to increase the current through the section from I1 to I2.

This is preferably effected by causing the voltage unit 13 (see Figure 5) to supply voltage to each of the laser sections with predetermined constant voltages across respective sections.

This results in automatic correction of the current through respective sections and in a constant quantity of free charge carriers, even when the ratio between injected current and the number of charge carriers changes. This applies to all sections of the laser.

Consequently, the wavelength of the emitted light will be held constant over said time period, even should the laser degrade. Although an exact wavelength may not be maintained over the full time period, the influence of degradation will at least be greatly reduced.

As distinct from conventional processes, it is not necessary to measure the current nor to correct the current to a certain predetermined value.

In actual fact, it is unnecessary to know the extent to which the laser has degraded in order to maintain a given operation point, and therewith the wavelength, when practicing the present invention.

The present invention thus solves the problem disclosed in the introduction.

Figure 5 is a block diagram of an arrangement used in accordance with the invention.

In operation, the voltage unit 13 functions to keep the voltage across the different laser sections 7-10 constant over a time period for maintaining a predetermined operation point. The various voltages required in this respect are determined, when characterizing or controlling the laser, as relevant voltages across the various laser sections for different operation points.

When characterizing the laser, for instance in accordance with the aforesaid patent specifications, the voltage across the various laser sections can be measured in respect of the different operation points.

The arrangement includes a microprocessor 14, or some corresponding device, for controlling four different voltage generators 16-19 via a D/A converter 15. Each of the voltage generators 16-19 controls one of the laser sections 7-10. The microprocessor 14 is connected to a storage unit (not shown) in which the different operation points are stored in the form of that voltage [which shall prevail] that exists across respective laser sections.

According to one preferred embodiment, the arrangement includes a circuit 20 which is adapted to measure the voltage across respective sections 7-10. The circuit 20 is designed to adjust the voltage unit 13 so that it will maintain a predetermined voltage for each laser section. This is effected in response to a signal delivered to the microprocessor 14 from the circuit 20 and representing respective measured voltages.

The microprocessor 14 and the D/A converter 15 can be replaced with a fully analog circuit. In such case, the circuit 20 may also be included in a similar analog circuit.

Although the invention has been described above with reference to an exemplifying embodiment thereof, it will be understood that the invention can be applied correspondingly to types of tuneable lasers other than a GCSR laser. The voltage generators may also be given any suitable design, as can also the circuit 20.

The present invention shall not therefore be considered limited to the aforedescribed embodiment, since variations can be made within the scope of the following claims.

What is claimed is:

ATTACHMENT C

Allowed International Application Claims as Amended Herein

1. (Amended) A method of controlling a tuneable laser that has been [characterised] characterized with respect to one or more suitable laser operation points, where each of said operation points is determined by the manner in which [the] different laser sections [(7-10)] are controlled in order to operate the laser [in] at a predetermined operation point, [characterised by] said method comprising the steps of: determining [the voltage] voltages across [the] different laser sections [(7-10)] for different operation points when controlling said laser; and holding the [voltage] determined voltages across the different laser sections [(7-10)] constant when the laser is in operation, [such as] to maintain a predetermined laser operation point.

2. (Amended) A method according to Claim 1, [characterised by] including the step of applying predetermined constant voltages across respective laser sections [(7-10) with the aid of] from a voltage [supply unit (13)] source.

3. (Amended) A method according to Claim [1 or] 2, [characterised by] including the steps of measuring the [voltage] voltages across respective laser sections [(7-10)], and adjusting the voltage [supply unit (13) so as] source to maintain said predetermined [voltage] voltages across each laser section [(7-10)].

4. (Amended) An arrangement for controlling a tuneable laser that has been [characterised] characterized with respect to suitable laser operation points,

where said operation points are determined by [the current] currents to be injected into the different laser sections [(7- 10)] in order for the laser to operate [in] at a predetermined operation point, [characterised by] said controlling arrangement comprising: a voltage [unit (13)] source which during operation of the laser functions to hold [the voltage] voltages across [the] different laser sections [(7-10)] constant over time in accordance with [the] a voltage that was measured across the different laser sections [(7-10)] in respect of [said] different operation points measured when [characterising] characterizing the laser, [such as] to maintain a predetermined laser operation point.

5. (Amended) An arrangement according to Claim 4 [, characterised by] comprising a circuit [(20) that functions] to measure [the voltage] voltages across respective laser sections [(7-10)], wherein the circuit [(20)] is adapted to adjust the voltage [unit (13)] source to maintain said predetermined [voltage] voltages across each laser section [(7-10)].

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Published:
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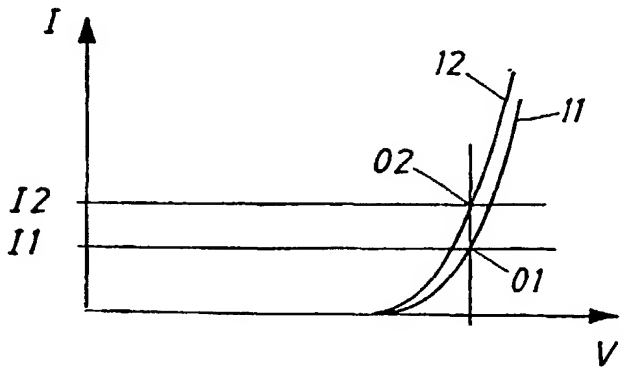
For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

(54) Title: A METHOD AND ARRANGEMENT FOR CONTROLLING A TUNEABLE LASER



(57) Abstract: A method of controlling a tuneable laser that has been characterised with respect to one or more suitable laser operation points, where each of said operation points is determined by the manner in which the different laser sections (7-10) are controlled in order to operate the laser in a predetermined operation point. The invention is characterised by determining the voltage across the different laser sections (7-10) for different operation points when controlling said laser; and holding the voltage across the different laser sections (7-10) constant when the laser is in operation, such as to maintain a predetermined operation point.

WO 01/03262 A1

Fig. 1

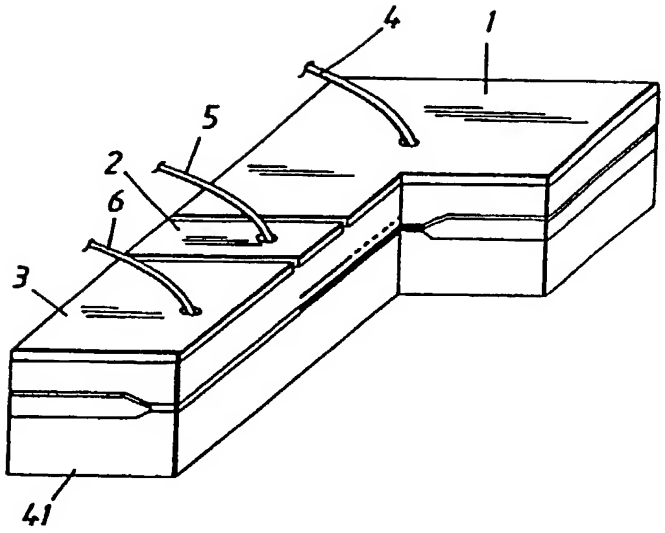


Fig. 2

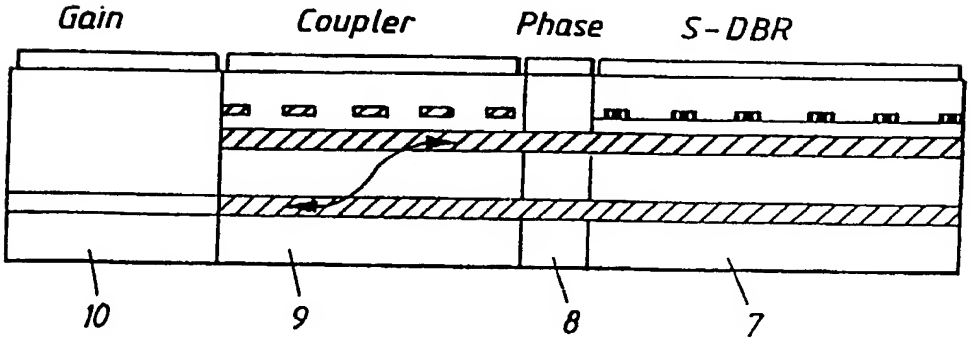


Fig.3

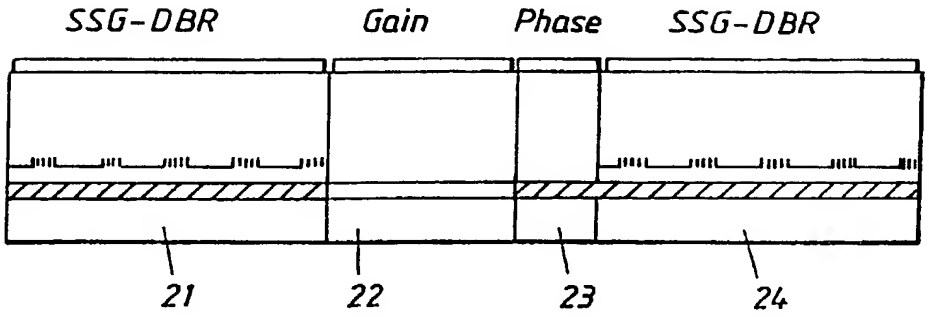


Fig.5

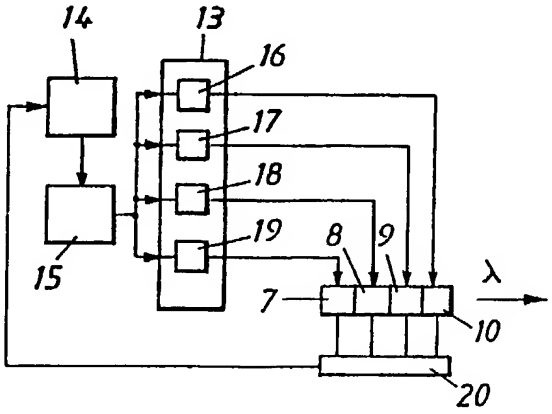
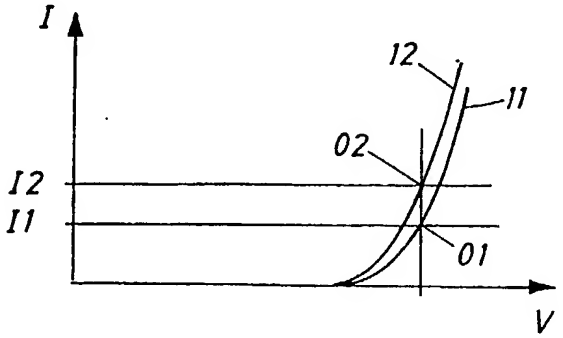


Fig.4



ATTORNEY'S DOCKET NO.
1435

DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that:
My residence, post office address and citizenship are as stated below next to my name; and
I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled A method and arrangement for controlling a tuneable laser,
the specification of which

(check one) ☐ is attached hereto.
☒ was filed on June 21, 2000 as
Application Serial No. PCT/SE00/01320
and was amended on _____ (if applicable).

I hereby state that I have reviewed and understand the contents of the above identified specification, including the claims, as amended by any amendment referred to above.

I acknowledge the duty to disclose information which is material to the examination of this application in accordance with Title 37, Code of Federal Regulations, §1.56(a), and Title 35 USC §102, as printed on the reverse of this Declaration a id which I have read.

I hereby claim foreign priority benefits under Title 35, United States Code, §119 of any foreign application(s) for patent or inventor's certificate listed below and have also identified below any foreign application for patent or inventor's certificate having a filing date before that of the application on which priority is claimed:

Prior Foreign Application(s)			Priority Claimed
9902604-9 (Number)	Sweden (Country)	6 July 1999 (Day/Month/Year Filed)	☒ Yes ☐ No
(Number)	(Country)	(Day/Month/Year Filed)	☐ Yes ☐ No

POWER OF ATTORNEY: As a named inventor, I hereby appoint Alfred J. Mangels, Registration No. 22,605, my attorney with full power of substitution and revocation to prosecute this application, to receive correspondence from and transact all business in the Patent Office connected therewith. The correspondence address of the above attorney is:

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I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code and that such willful false statements may jeopardize the validity of the application or any patent issued thereon.

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